SECURITY VEHICLE SYSTEM, VEHICLE AND ASSOCIATED METHODS

Related Applications

This application is a continuation-in-part of co-pending U.S. Patent Application Serial Nos. 09/975,095, and 09/975,090, both filed on October 10, 2001, which are incorporated herein by reference in their entireties.

Field of the Invention

The present invention relates to the field of remote vehicle systems and more particularly the field of security vehicles and associated methods.

Background of the Invention

Areas that are hard to access, i.e., areas having a low clearance or containing many obstacles, can only generally be monitored from a distance. For example, if surveillance is to be conducted near an area having a low clearance or containing many obstacles, i.e., conducting surveillance on a vehicle or within a predetermined area having many obstacles, such as an office or a passenger airplane, it is difficult to

position a surveillance vehicle therein. It becomes even more difficult to maneuver a security or surveillance vehicle while simultaneously concealing the surveillance or security vehicle. Some alternatives include listening devices or video cameras, for example, that can be positioned in areas where they are not likely to be found. These listening and video devices, however, are not mobile and cannot follow an object in motion, such as a vehicle. Further, these devices can be difficult and time consuming to install. Another disadvantage is that these devices are incapable of performing various other tasks depending on the results of the surveillance conducted, e.g., extinguish a fire if a fire is detected by the surveillance equipment.

Surveillance vehicles and systems are generally known and have been used in the surveillance industry for many years. For example, U.S. Patent No. 4,709,265 titled *"Remote Control Mobile Surveillance System"* by Silverman et al. discloses a surveillance vehicle used to monitor an environment. This surveillance vehicle, however, is rather cumbersome and limited in directional positioning. These limitations on the vehicle are disadvantageous if the vehicle is to be used in an area having a low clearance or an area having many obstacles blocking a clear path of travel, e.g., a warehouse having many boxes of cargo positioned on pallets or in an aircraft cargo hold having cargo packed tightly therein.

Summary of the Invention

With the foregoing in mind, the present invention advantageously provides a security vehicle system including a security vehicle having a low clearance, multi-directional movement capabilities, and associated

methods. The present invention also advantageously provides a security vehicle that is light-weight and easy to maneuver. The security vehicle of the present invention is further advantageously modular so that it can be adapted with many different types of security devices depending on the type of security or surveillance that is to be conducted and has modules or portions that are readily interchangeable with like modules in other portions of the vehicle. This, in turn, advantageously reduces the number of parts for the vehicle, provides ease in manufacture and replacement of damaged or lost parts.

The present invention advantageously recognizes the problems associated with security vehicles that are not readily maneuverable to avoid obstacles and that do not have low clearance and provides unique solutions including a low clearance vehicle capable of multi-directional movement. The present invention also identifies the source of the problems associated with security vehicles that cannot access narrow areas and provides unique solutions of a security vehicle including one that can collapse and thereby provides ready access to substantially narrow areas. The present invention further recognizes the problem associated with the cost and inconvenience of repairing a security vehicle. The present invention still further recognizes the problems associated with providing a security vehicle that is adapted to conduct surveillance and to perform various tasks based on that surveillance. The present invention also recognizes the problems associated with security or surveillance vehicles that have limited effective ranges and provides a solution of security devices connected to the security vehicle to thereby substantially increase the effective range of the security vehicle.

More particularly, the present invention provides a

security vehicle system having a predetermined effective range. The security vehicle system preferably includes a remote controller having a control signal emitter positioned to emit a control signal. The security vehicle system also preferably includes a collapsible security vehicle having a main body. The collapsible security vehicle is preferably positioned between an extended position and a retracted position responsive to a control signal emitted by a remote controller so that the security vehicle can be readily positioned to access substantially narrow areas. The main body preferably includes a pair of security vehicle bodies, each including a front, a rear, and first and second sides extending between the front and rear. The security vehicle also preferably includes a pair of security vehicle body connectors positioned to extend between the pair of security vehicle bodies to collapsibly connect the pair of security vehicle bodies. Each of the pair of security vehicle bodies also preferably includes a cargo receiving area adapted to receive cargo, at least one security device connected thereto, and a plurality of omni-directional wheels connected to outer peripheries thereof to provide multi-directional movement of the security vehicle. The security vehicle also preferably includes a control signal receiver connected to the main body and positioned to receive the control signal emitted from the control signal emitter of the remote controller and at least one drive assembly connected to the main body and to the plurality of omni-directional wheels and responsive to the control signal emitted by the control signal emitter of the remote controller to drive the plurality of omni-directional wheels.

The present invention also includes a collapsible security vehicle having a predetermined effective range and a short width when positioned in a collapsed position

to thereby define a narrow security vehicle that can be readily positioned and maneuvered within a predetermined area having obstacles and narrow areas. The security vehicle preferably includes a collapsible main body having a pair of security vehicle bodies collapsibly connected to one another. Each of the pair of security vehicle bodies preferably includes a front, a rear, and first and second sides extending between the front and rear. The security vehicle also preferably includes a pair of security vehicle body connectors positioned to extend between the pair of security vehicle bodies to collapsibly connect the pair of security vehicle bodies so that the security vehicle can be positioned between an extended position and a retracted position. The pair of security vehicle bodies are preferably interchangeable. Each of the pair of security vehicle bodies preferably includes respective first and second omni-directional wheels connected to the respective first and second sides of each of the pair of security vehicle bodies, and respective first and second drive assemblies connected to the respective first and second omni-directional wheels to drive the respective first and second omni-directional wheels.

The security device of the present invention further preferably includes a plurality of power units positioned to interchangeably connect to each of the pair of security vehicle bodies, and to provide power to the respective first and second drive assemblies of each of the pair of security vehicle bodies.

The present invention also preferably includes a method of maneuvering a security vehicle having a base with a longitudinal axis, a low clearance, and at least one security device connected thereto. The method preferably includes moving the security vehicle in a first predetermined direction so that the longitudinal

axis of the vehicle is substantially parallel to the path of travel of the security vehicle. The method can also preferably include moving the security vehicle in a second predetermined direction so that the longitudinal axis of the vehicle is substantially perpendicular to the path of travel of the security vehicle. The method further preferably includes moving the security vehicle in a third predetermined direction so that the longitudinal axis of the vehicle is substantially transverse to the path of travel of the security vehicle.

The present invention further preferably includes a method of conducting surveillance with a security vehicle having a base with a longitudinal axis, a lateral axis, and at least one security device connected thereto. The method preferably includes moving the security vehicle in a first predetermined direction so that the longitudinal axis is substantially parallel with a path of travel of the security vehicle and the lateral axis is substantially perpendicular with the path of travel of the security vehicle. The method also preferably includes collapsing the security vehicle to decrease the width of the security vehicle and provide ready access to narrow areas. The method further preferably includes moving the security vehicle in a second predetermined direction so that the longitudinal axis is substantially perpendicular to the path of travel of the security vehicle and the lateral axis is substantially parallel to the path of travel of the security vehicle.

The security system, device, and methods of the present invention advantageously allow for surveillance to be conducted in areas having narrow paths of travel and a low clearance. The present invention also advantageously allows a security vehicle to be maneuvered around obstacles positioned in the path of travel of the security vehicle. The present invention further

advantageously allows a security vehicle to be maneuvered on many different types of terrains, i.e., smooth, ice, mountainous, roughened, and wet surfaces. The present invention still further advantageously provides an interchangeable pair of security vehicle bodies as well as interchangeable power units positioned in each of the pair of security vehicle bodies to advantageously decrease maintenance and repair costs. This advantageously allows for a portion of a security vehicle to be replaced instead of a need to replace the entire security vehicle. This also advantageously allows for the plurality of power units to be interchanged between various portions of the security vehicle. Further, the interchangeability of the power units also allows for the user to have additional charged power units available that can be adapted to replace a power unit that has lost its charge, regardless of the location of the power unit.

Brief Description of the Drawings

Some of the features, advantages, and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a fragmentary environmental view of a security vehicle being used on board a commercial aircraft according to the present invention;

FIG. 2 is an environmental view of a security vehicle system according to the present invention;

FIG. 3 is a front perspective view of a security vehicle according to the present invention;

FIG. 4 is a top perspective view of a security vehicle having the top removed according to the present invention;

FIG. 5 is an exploded perspective view of security vehicle having the top removed according to the present

invention;

FIG. 6 is a top plan view of a security vehicle showing the range of motion according to the present invention;

FIG. 7 is a side elevation view of a pair of security vehicles having varying heights according to the present invention;

FIG. 8 is an exploded perspective view of a security vehicle showing the omni-directional wheels removed and a pair of tracks being connected to the vehicle according to the present invention;

FIG. 9 is a top perspective view of a security vehicle showing a main body, forward drive unit, rear drive unit and a plurality of power units connected thereto according to the present invention;

FIG. 10 is an exploded perspective view of a security vehicle showing the interchangeability of the forward and rear drive units and the power units according to the present invention;

FIG. 11 is a perspective view of a security vehicle having a forward and rear drive unit, a plurality of power units, and a pair of tracks connected thereto according to the present invention;

FIG. 12 is a side elevation view of an omni-directional wheel according to the present invention;

FIG. 13 is another side elevation view of an omni-directional wheel according to the present invention;

FIG. 14 is a exploded perspective view of an omni-directional wheel according to the present invention;

FIG. 15 is a front perspective view of a security vehicle having a camera positioned in a cavity of the main body according to the present invention;

FIG. 16 is a front perspective view of a security vehicle having a fire extinguishing device extending outwardly therefrom according to the present invention;

FIG. 17 is a flow chart showing the use of the security vehicle system according to the present invention;

FIG. 18 is a schematic diagram showing a control signal in the security vehicle system according to the present invention;

FIG. 19 is a perspective view of a security vehicle having security devices positioned therein according to the present invention; and

FIG. 20 is a perspective view of a security vehicle in the extended position according to the present invention;

FIG. 21 is a perspective view of a security vehicle in the collapsed position according to the present invention; and

FIG. 22 is a perspective view of the construction of the frame of a security vehicle according to the present invention.

Detailed Description of the Preferred Embodiments

The present invention will now be described more fully hereinafter with reference to the accompanying drawings which illustrate preferred embodiments of the invention. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout, the prime notation, if used, indicates similar elements in alternative embodiments.

As best illustrated in FIGS. 1-19, the present invention advantageously provides a security vehicle system 30, a security vehicle 40, an omni-directional

wheel 90, and associated methods. More particularly, as best illustrated in FIGS. 1 and 2, the security vehicle system 30 of the present invention includes a remote controller 32 and a security vehicle 40 to access areas having a low clearance or having many obstacles 35 positioned therein, such as on an aircraft for example. The security vehicle 40 of the security vehicle system 30 and of the present invention can advantageously include at least one security device 65 connected thereto. As best illustrated in FIGS. 15 and 16, the security device 65 can be any number of security devices, such as a bomb detection device, a bomb disarming device, a fire detection device, a fire extinguishing device, a poison detection device, a poison disabling device, a camera, a listening device, a water purity testing device, or any other types of security and surveillance devices as understood by those skilled in the art. The security device 65 can also advantageously be provided by a plurality of security devices. For example, a security vehicle 40 having a fire extinguishing device connected thereto would preferably also include a camera so that the user U can verify the location of the security vehicle 40. The security vehicle system 30 includes a predetermined effective range, e.g. ten feet. The predetermined effective range can be controlled by the distance that the security device 65 can be effectively used without moving the security vehicle 40. For example, the effective range of a camera may be ten feet but can be increased to twenty feet if the camera or the security vehicle 40 upon which the camera is mounted is moved.

As best illustrated in FIG. 2, the remote controller 32 of the security vehicle system 30 can advantageously include a control signal emitter 36 positioned to emit a control signal 34. The control signal 34 can

advantageously be adapted to travel over great distances or over shorter distances as understood by those skilled in the art. The control signal 34 emitted by the control signal emitter 36 can advantageously be a radio frequency, microwave frequency, an infra red communication link, a satellite communications link, or any other type of control signal as understood by those skilled in the art.

As best illustrated in FIGS. 3-7, the present invention and the security vehicle system 30 include a security vehicle 40. As described above, the security vehicle 40 preferably has a predetermined effective range and a low vertical height to thereby define a low clearance security vehicle. The security vehicle 40 includes a main body 41 having a bottom 47, a top 46, a plurality of side walls 48 extending therebetween, a front 42, a rear 43, and first and second sides 44, 45 extending between the front 42 and the rear 43. The main body 41 of the security vehicle 40 can advantageously be formed of aluminum, for example, or any other material that is light in weight, relatively strong, heat resistant, water resistant, and non-corrosive.

The main body 41 of the security vehicle 40 can also advantageously include a medial body portion 49 having a cargo receiving area 66 adapted to receive cargo. For example, the cargo can be a security device 65, such as those described above. The cargo receiving area 66 can also advantageously be used to transport hazardous cargo into or out of a hazardous area, e.g., the security vehicle 40 can be positioned into an area having a hazardous material spill and a hazardous material technician working in the contaminated area can insert a sample into the cargo receiving area 66 to be analyzed at an off site lab. In this scenario, the security vehicle 40 can also be adapted to sample air quality in the

contaminated area and bring the sample out to an uncontaminated area to be analyzed. This advantageously decreases the risks taken by an operator by increasing a distance between the operator and the hazardous material.

The cargo receiving area 66 of the security vehicle 40 can further include a cavity 67 positioned between the sidewalls 48 adjacent the front 42, rear 43, and first and second sides 44, 45 of the main body 41. The security device 65 can advantageously be positioned to extend from the cargo receiving area 66 to thereby increase the predetermined effective range of the security vehicle 40 as described above and as illustrated in FIG. 1.

The security device 65 can, for example, be positioned in a retracted position so that the security vehicle 40 can maintain a low vertical clearance. The security device 65 can then be extended out of the cavity 67, as illustrated in FIG. 1 by a camera being extended out of the top of the security vehicle 40, for example. Extending the security device 65 out of the cavity 67 advantageously provides the security vehicle 65 with a greater effective area. For example, when the camera illustrated in FIG. 1 is positioned in the retracted position, it can only be positioned to view areas directly in front of the security vehicle 40. When the camera is extended upwardly and pivoted, however, as illustrated in FIG. 1, the camera can advantageously be used to view areas surrounding the security vehicle 40.

The security vehicle system 30, and security vehicle 40 of the present invention can also advantageously include a plurality of omni-directional wheels 90 connected to the main body 41 of the security vehicle to provide multi-directional movement to the security vehicle 40. The security vehicle 40 can also advantageously include a controller connected to the main

body 41 of the security device 40 to receive the control signal 34 emitted from the control signal emitter 36. The controller can advantageously include a control signal receiver 80 and a control signal encoder 82 positioned in communication with the control signal receiver 80 to encode the control signal 34. More particularly, the security vehicle 40 can further advantageously include one controller per omni-directional wheel 90. Each of the controllers are positioned to receive the control signal 34, encode the control signal, send that signal, i.e., the encoded signal, to the omni-directional wheel, and send the encoded signal back to the controller as confirmation that the instruction contained in the signal has been carried out. The security vehicle 40 is the responsive to the encoded control signal. For example, as best illustrated in FIG. 18, the control signal receiver 80 can advantageously be provided by a controller positioned to receive the control signal 34 from the remote controller 32. The control signal 34 is encoded by the control signal encoder 82 and passed through an amplifier 83 where it can advantageously be strengthened, or amplified. The security vehicle 40 is then responsive to the encoded signal, an optical feedback signal 84 is sent back to the control signal receiver/encoder 80, 82 to verify that the control signal 34 sent by the remote controller 32 has been carried out by the security vehicle 40. Although FIG. 18 illustrates the signals being transmitted in one direction, it shall be understood that the signals can be transmitted in a two way directional configuration as understood by those skilled in the art.

As best illustrated in FIG. 7 the security vehicle 40 can advantageously have various vertical heights H_1, H_2. It is preferable, however, that the security vehicle 40

height is less than about twelve inches, and more preferably between the range of about four to seven inches. The security vehicle 40 can advantageously have a width of between about ten to twenty-four inches, but preferably about seventeen inches. A width of seventeen inches is preferable because this is approximately the width of a conventional aisle in an commercial airplane. Similarly, a security vehicle 40 having a vertical height between about four to seven inches is advantageous because it can readily be positioned to extend beneath cars, as best illustrated in FIG. 1 and within spaces encountered on a commercial airplane, as best illustrated in FIG. 2.

As best illustrated in FIGS. 9-10, the security vehicle 40 of the present invention and of the security vehicle system 30 can further advantageously include a forward drive unit 50, and a rear drive unit 70 positioned to detachably and interchangeably connect to the respective front 42 and rear 43 of the main body. The forward and rear 50, 70 drive units can advantageously each include a front 52, 72, a rear 53, 73, first 54, 74 and second 55, 75 sides extending between the front 52, 72 and rear 53, 73 positioned adjacent the first 44 and second 45 sides of the main body 41. The rear of the forward drive unit 53 can advantageously be interchangeably connected to the front of the main body 42 so that the forward drive unit 50 is positioned to extend from the front of the main body 42. Similarly, the front of the rear drive unit 72 can advantageously be interchangeably connected to the rear of the main body 43 so that the rear drive 70 is positioned to extend from the rear of the main body 43. Respective first and second omni-directional wheels 91, 92 are connected to the respective first and second sides of the respective front 54, 55 and rear 74, 75 drive

units. The forward drive unit 50 can advantageously include first and second forward drive assemblies 61, 64 connected to the respective first and second omni-directional wheels 91, 92 to drive the respective first and second omni-directional wheels 91, 92. Similarly, the rear drive unit 70 can advantageously include first and second rear drive assemblies 81, 84 connected to the respective first and second omni-directional wheels 91, 92 to drive the respective first and second omni-directional wheels 91, 92. Similar to the main body of the security vehicle, and as illustrated in FIGS. 9 and 10, both the front and rear drive units 50, 70 can advantageously include a vertical height less than about twelve inches, and preferably less than about eight inches. For example, security vehicles with a vertical height of about 2 to 7 inches are more preferable such as 4 inches and 7 inches for selected applications.

As mentioned above and as best illustrated in FIG. 10, the front and rear drive units 50, 70 can advantageously be interchangeably connected to the main body of the security device 41. For example, the front drive unit 50 can advantageously be connected to the rear of the main body 43 and the rear drive unit 70 can advantageously be connected to the front of the main body 42. This advantageously allows for ready assembly of a security device that is shipped in pieces, for example. This also advantageously allows for quick replacement of a damaged unit without the need to replace the entire security vehicle 40.

The security vehicle 40 of the security vehicle system 30 and of the present invention advantageously includes a plurality of power units 62 positioned to interchangeably connect to the main body of the security vehicle 41, the forward drive unit 50 and the rear drive unit 70. As best illustrated in FIGS. 9-10, the

plurality of power units 62 can be interchangeably connected to portions of the front and rear drive units 50, 70 and the main body of the security vehicle 41. The power units 62 can advantageously be batteries, for example, and more particularly, the batteries can advantageously be rechargeable lithium batteries or any other type of power unit 62 that has a long life as understood by those skilled in the art. This is advantageous because it allows for ready replacement of individual power units 62 no matter where they are positioned, i.e., one power unit 62 can be connected to portions of the main body of the security vehicle 41, the forward drive unit 50 or the rear drive unit 70 as needed. The plurality of power units 62 are connected to the forward drive unit 50, the rear drive unit 70, the control signal receiver 80, the control signal encoder 82, and the amplifier 83 to provide power to the respective forward drive assembly 50, the rear drive assembly 70, the control signal receiver 80, the control signal encoder 82, and the amplifier 83.

As best illustrated in FIG. 15, the side walls of the main body 48 further include a plurality of security device access openings 60 formed therein to provide ready access of the security device 65 positioned within the cargo receiving area 66 to an area positioned exterior the cargo receiving area 66. For example, as illustrated in FIG. 15, the security device access opening 60 can advantageously be a rectangular opening formed in a sidewall 48 adjacent the front of the main body 42 so that a camera can be positioned to view the area exterior the main body 41. The side walls of the main body 48 still further include a plurality of security device access opening covers 63 positioned to cover each of the plurality of security device access openings 60 when not in use by the security device 65. The security device

access opening cover 63 can advantageously be positioned to protect the security device 65 positioned behind the security device access opening 60. For example, the security device access opening cover 63 can advantageously be a hard transparent plastic material positioned over the security device access opening 60 so that a security device 65, such as a camera, can still be used when the security device access cover 63 is engaged.

The security vehicle 40 can also advantageously include a pair of main axles 120 defined by a front main axle 122 connected between the respective first and second omni-directional wheels 91, 92 of the forward drive unit 50 and a rear main axle 124 connected between the respective first and second omni-directional wheels 91, 92 of the rear drive unit 70. The front and rear main axles 122, 124 can advantageously include a first end 126 positioned adjacent the first side of the main body 44 and a second end 128 positioned adjacent the second side of the main body 45. The front and rear main axles 122, 124 can advantageously be made of an aluminum material or any other type of material having light weight and high strength properties as understood by those skilled in the art. The front and rear main axles 122, 124 can also advantageously include a plurality of omni-directional wheel connectors 130 each connected to the respective first and second ends 126, 128 of the respective front and rear main axles 122, 124 and including one of the respective first and second ends 126, 128 of one of the respective front or rear main axles 122, 124 extending from a medial portion 131 thereof. Each of the plurality of omni-directional wheel connectors 130 can also advantageously include a plurality of lugs 132 positioned in an annular configuration surrounding the main axle 120 extending from the medial portion 131 of the omni-directional wheel

connector 130. The omni-directional wheel connector 130 can advantageously be integrally formed with the main axle 120 to thereby increase the strength of the connection between the omni-directional wheel connector 130 and the main axle 120.

As best illustrated in FIGS. 8 and 11, the security vehicle system 30 and the security vehicle 40 of the present invention can advantageously include a track converter 140 positioned to replace the plurality of omni-directional wheels 90 with a pair of tracks 142. The track converter 140 can advantageously include a plurality of track receiving members 144 each having a size slightly larger than the size of each of the plurality of omni-directional wheels 90. The track receiving members 144 can advantageously be provided by a track wheel 145, for example, having a track wheel hub 146 and a track wheel rim 147. The track wheel rim 147, can advantageously be slightly raised so that a track wheel recess 148 is formed to receive the tracks 142. The track wheel recess 148 can advantageously be smooth for high speed travel, or roughened to thereby increase friction between the track wheel 145 and the track 142 during travel over rough terrain.

The track receiving members 144 can advantageously be positioned to connect to one of the plurality of omni-directional wheel connectors 130. The track wheel 145 can therefore have a configuration substantially similar to the configuration of the omni-directional wheel connector 130 to thereby insure that the track wheel 145 can be positioned to engage the omni-directional wheel connector 130. The pair of tracks 142 can then be positioned to connect between a pair of the track receiving members 144. Each of the tracks 142 can advantageously be made of a heavy-duty plastic material, or any other type of material that is flexible and has

high strength properties as understood by those skilled in the art.

As best illustrated in FIGS. 12-14, the omni-directional wheel 90 of the security vehicle system 30, the security vehicle 40, and of the present invention advantageously includes a wheel hub 94 having a vertical height when positioned on a vehicle of less than about twelve inches and being formed of a plastic material. The wheel hub 94 can advantageously include a hub main body 96 having omni-directional wheel connecting means for connecting portions of the omni-directional wheel 90 to the security vehicle 40.

The omni-directional wheel connecting means can advantageously be provided by an axle mount 100 formed in a medial portion of the hub main body 96. The axle mount 100 can advantageously include a main axle receiving portion 102 and a plurality of lug receiving portions 104 formed in a medial portion thereof and positioned in an annular configuration to surround the main axle receiving portion 102. Each of the lug receiving portions 104 can advantageously be positioned to receive one of a plurality of lugs 132 extending outwardly from portions of a vehicle axis, i.e., the security vehicle main axle 120, to thereby secure the omni-directional wheel 90 to the vehicle. The main axle receiving portion 102 and the lug receiving portion can advantageously be openings formed in the hub main body 96. The lug receiving portions 104 can also advantageously include a configuration substantially similar to the configuration of the lugs 132 extending from the main axle 120. The hub main body 96 can further include an outer periphery portion 98 having a plurality of recesses 99 formed therein. Each of the plurality of recesses 99 can have a substantially arcuate shaped recessed surface formed therein. The recesses 99 can advantageously be

positioned to extend across the outer peripheries 98 of the hub main body 96. The outer peripheries of the hub main body 98 can advantageously have a diameter D_1 that is about twice as large as a diameter D_2 of inner peripheries of the hub main body 96. This advantageously allows for simple molding of the wheel hub 94.

As best illustrated in FIG. 14, the omni-directional wheel 90 can also advantageously include wheel member mounting means integrally formed of substantially the same material as the wheel hub 94 and positioned to surround the outer peripheries 98 of the hub main body 90 and extend outwardly therefrom. The wheel member mounting means can advantageously be provided by a plurality of pairs of spaced-apart wheel member mounting arms 107 integrally formed of substantially the same material as the wheel hub 94. The wheel member mounting arms 107 can advantageously be positioned to surround the outer peripheries 98 of the hub main body 96 and extend outwardly therefrom. Each of the plurality of pairs of wheel member mounting arms 107 can advantageously be defined by a first wheel member mounting arm 108 having a first predetermined elevation X_1 and a second wheel member mounting arm 109 positioned substantially opposite the first wheel member mounting arm 108 and having a second different predetermined elevation X_2. The first and second predetermined elevations X_1, X_2 are different to thereby advantageously enhance the strength and efficiency of the omni-directional wheel 90.

The omni-directional wheel 90 can further advantageously include a plurality of separate and spaced-apart wheel members 110 positioned to connect to the wheel member mounting arms 107 and overlie the outer peripheries 98 of the hub main body 96. Each of the plurality of wheel members 110 are therefore adapted to operate independently of other ones of the plurality of

wheel members 110 and independently of the wheel hub 94. Each of the plurality of wheel members 110 can therefore be rotated regardless of movement of the wheel hub 94. When one of the plurality of wheel members 110 is in contact with a support surface, such as the floor of an airplane cabin, the wheel member can be adapted to rotate, regardless of whether the wheel hub 94 is rotating. Each of the plurality of wheel members 90 can advantageously be connected to the wheel hub 94 to provide an omni-directional wheel 90 having a vertical height less than about twelve inches to thereby define an omni-directional wheel 90 having a low clearance. The vertical height of the omni-directional wheel, however, is preferably between the range of about four to seven inches as best illustrated in FIG. 6 and as indicated by H_1 and H_2. The vertical height of the omni-directional wheel 90 can be slightly larger than the vertical height of the side walls of the main body 48 of the security vehicle 40. The vertical height of the omni-directional wheel 90, therefore, controls the vertical height of the security vehicle 40. When the omni-directional wheels are mounted to the main body 41 of the security vehicle 40, the vertical height of the security vehicle 40, i.e., the main body 41 having the omni-directional wheels 90 connected thereto, does not exceed the vertical height of the omni-directional wheels 90.

Each one of the plurality of wheel members 110 of the omni-directional wheel 90 can further include a wheel main body 112 having a bulbous shape, a lateral axis, and a longitudinal axis being substantially longer than the lateral axis. Each one of the plurality of wheel members 110 can advantageously be connected between the first wheel member mounting arm 108 having the first predetermined elevation X_1 and the second wheel member mounting arm 109 having the second predetermined

elevation X_2 and positioned to overlie one of the plurality of recesses 99. Each of the plurality of wheel members 110 are advantageously connected to the wheel hub 94 in a symmetrical configuration. Therefore each of the plurality of wheel members 110 are positioned substantially opposite the other ones of the plurality of wheel members 110. Further, the plurality of wheel members 110 preferably includes six wheels, but any number of wheel members 110 can be used to form the omni-directional wheel 90. For example, the plurality of wheel members 110 can include three upper wheel members 110 and three lower wheel members 110 positioned substantially opposite the upper wheel members and further positioned substantially symmetrical the upper wheel members.

As best illustrated in FIG. 14 each of the plurality of pairs of wheel member mounting arms 107 can advantageously extend at an angle θ_1 between about 30 and 60 degrees from the outer peripheries of the hub main body 98. The angle θ_1 between each of the pairs of wheel member mounting arms 107 and the hub main body 96, however, is preferably about 45 degrees. The second wheel member mounting arm 109 can advantageously be positioned at an angle θ_2 between about 30 and 60 degrees relative to the first wheel member mounting arm. Therefore, when each of the plurality of wheel members 110 are connected between the first and the second wheel member mounting arms 108, 109, each of the plurality of wheel members 110 will be tilted substantially the same angle θ_2 as the angle between the first and second wheel member mounting arms 108, 109. Each one of the plurality of recesses 99 can advantageously include a length substantially similar to a distance between the first and second wheel member mounting arms 108, 109.

The wheel hub 94, the wheel member mounting arms

107, and the plurality of wheel members 110 are all formed of a plastic material. The plastic material is preferably polyurethane, but any other plastic material that can be easily molded, has high strength properties and is light in weight can also be used as understood by those skilled in the art.

As best illustrated in FIG. 14, the omni-directional wheel 90 of the present invention, the security vehicle 40, and the security vehicle system 30, can also advantageously include a plurality of wheel member mounting rods 114 each positioned to extend through a medial portion of the wheel main body 112 of each of the plurality of wheel members 110. The wheel member mounting rods 114 can be connected to and extend between the first and second wheel member mounting arms 108, 109 so that each of the plurality of wheel 110 members are supported by at least one of the plurality of wheel member mounting rods 114 to overlie the respective one of the plurality of recesses 99 formed in the main body of the wheel hub 94. The wheel member mounting rod 114 can advantageously be made of aluminum, or any other type of strong and light weight material as understood by those skilled in the art.

The omni-directional wheel 90 of the present invention, the security vehicle 40, and the security vehicle system 30, can further advantageously include a pair of fasteners 116 each positioned to extend through the respective first and second wheel member mounting arms 108, 109 and into one of the plurality of wheel member mounting rods 114 to thereby fasten one of the plurality of wheel members 110 between the first and second wheel member mounting arms 108, 109. This advantageously secures each of the plurality of wheel members 110 between each of the plurality of pairs of mounting arms 107. The fasteners 116 can advantageously

be pins or screws, for example. The pins can have a diameter that is large enough to provide a tight fit through portions of the first and second wheel member mounting arms 108,109, but loose enough so that when the fasteners 116 engage inner periphery portions of the wheel member mounting rods 114 positioned in medial portions of each of the plurality of wheel members 110, each of the plurality of wheel members 110 are still adapted to freely rotate independent of the wheel hub 94, and of the other plurality of wheel members 110.

When the plurality of omni-directional wheels 90 are connected to the main body of the security vehicle 40, the security vehicle 40 can advantageously be moved in multiple directions. The omni-directional wheels 90 are rotated at various predetermined speeds to adjust the direction and speed of the security vehicle 40. For example, if it is desired to move the security vehicle 40 in a transverse direction, then the omni-directional wheels on one side of the security vehicle 40 can be rotated faster than the omni-directional wheels 90 of the other side of the security vehicle 40. This advantageously allows the plurality of wheel members 110 on one side of the security vehicle to contact a support surface more often than the plurality of wheel members 110 on the other side of the security vehicle 40, thereby moving the security vehicle in the transverse direction.

The present invention further advantageously includes a method of maneuvering a security vehicle 40 having a base with a longitudinal axis, a low clearance, and at least one security device 65 connected thereto. The method can advantageously include moving the security vehicle 40 in first predetermined direction P_1 so that the longitudinal axis of the security vehicle 40 is substantially parallel to the path of travel of the security vehicle 40. The method can also advantageously

include moving the security vehicle 40 in a second predetermined direction P_2 so that the longitudinal axis of the security vehicle 40 is substantially perpendicular to the path of travel of the security vehicle 40. The method can further advantageously include moving the security vehicle 40 in a third predetermined direction P_3 so that the longitudinal axis of the security vehicle 40 is substantially transverse to the path of travel of the security vehicle 40.

The method of maneuvering the security vehicle 40 can still further advantageously include maneuvering the security vehicle 40 in a predetermined area having a clearance of less than about twelve inches and retracting a security device cover 63 to thereby provide access to the security device 65 connected to the security vehicle 40. The method can also advantageously include extending a security device 65 to a position away from the security vehicle 40 and retracting the security device 65 to a position close to the security vehicle 40. The method can further advantageously include retracting the security device cover 63 to thereby cover the security device 65 connected to the security vehicle 40.

The present invention also advantageously includes a method of conducting surveillance with a security vehicle 40 having a base with a longitudinal axis, a lateral axis, at least one security device 65 connected thereto, and a predetermined effective range. The method includes moving the security vehicle 40 in a first predetermined direction P_1 so that the longitudinal axis is substantially parallel with a path of travel of the security vehicle 40 and the lateral axis is substantially perpendicular with the path of travel of the security vehicle 40. The method also includes extending the at least one security device 65 from the security vehicle 40 to thereby expand the predetermined effective range of

the security vehicle 40. The method further advantageously includes moving the security vehicle 40 in a second predetermined direction P_2 so that the longitudinal axis is substantially perpendicular to the path of travel of the security vehicle 40 and the lateral axis is substantially parallel to the path of travel of the security vehicle 40.

The method of conducting surveillance also advantageously includes moving the security vehicle 40 in a third predetermined direction P_3 so that the longitudinal axis and the lateral axis are both substantially transverse the path of travel of the security vehicle 40 and retracting the at least one security device 65 to the security vehicle 40.

The present invention also advantageously includes a method of forming an omni-directional wheel 90 for providing multi-directional movement. The method of forming the omni-directional wheel 90 can advantageously include integrally forming a wheel hub 94 having a plurality of pairs of wheel member mounting arms 107 extending outwardly therefrom, forming a plurality of recesses 99 in outer periphery portions of the wheel hub 98, and connecting a plurality of wheel members 110 between each of the plurality of pairs of wheel member mounting arms 107, and operating each of the plurality of wheel members 110 independently of another one of the plurality of wheel members 110 and independently of the wheel hub 94.

The method can further advantageously include extending a wheel member mounting rod 114 through each of the plurality of wheel members 110 and connecting each of the plurality of wheel members 110 between one of the plurality of pairs of wheel member mounting arms 107 and inserting wheel member securing members 116 through the wheel member mounting arms 107 into the wheel member

connecting rod 114 to thereby secure the wheel member 110 between one of the plurality of pairs of wheel member mounting arms 107.

In another embodiment, as best illustrated in FIGS. 20-22, the security vehicle 40' of the present invention can also preferably be provided by a collapsible security vehicle. As best illustrated in FIGS. 20-21, the security vehicle can advantageously be positioned between an extended position E_1 and a collapsed position E_2. The extended position E_1 advantageously provides a security vehicle 40' having a substantially low clearance so as to enhance maneuverability in areas having obstacles with low clearance. The collapsed position E_2 advantageously provides a security vehicle 40' having a short width so that the security vehicle 40' can be readily positioned to access areas having narrow passageways. As perhaps best illustrated in FIGS. 20-22, the security vehicle 40' can further preferably include a pair of security vehicle bodies 38', 39', each having a bottom 47', a top 46', a plurality of side walls 48' extending therebetween, a front 42', a rear 43', and first and second sides 44', 45' extending between the front 42' and the rear 43'. Each of the pair of security vehicle bodies 38', 39' of the security vehicle 40' can advantageously be formed of aluminum, for example, or any other material that is light in weight, strong, heat resistant, water resistant, and non-corrosive, as understood by those skilled in the art.

As best illustrated in FIG. 20, the extended position E_1 of the security vehicle is further defined by a bottom portion of each of the pair of security vehicle bodies 38', 39' positioned substantially parallel to a support surface positioned to underlie the security vehicle 40'. As perhaps best illustrated in FIG. 2, the collapsed position of the security vehicle 40 is further

defined by a bottom portion of each of the pair of security vehicle bodies 38', 39' positioned substantially perpendicular to a support surface positioned to underlie the security vehicle 40'. More particularly, when positioned in the extended position E_1, the front of one of the pair of security vehicle bodies 42' is positioned to face the rear of the other one of the pair of security vehicle bodies 43'. Similarly, when positioned in the retracted position E_2, the front of one of the pair of security vehicle bodies 42' is positioned substantially adjacent the rear of the other one of the pair of security vehicle bodies 43'.

As best illustrated in FIGS. 20-22, the security vehicle 40' of the present invention can also preferably include a pair of security vehicle body connectors 130' connected to and extending between each of the pair of security vehicle bodies 38', 39'. Each of the pair of security vehicle body connectors 130' can be formed of a composite material, for example, or any other type of material that has high strength properties and is preferably light in weight, as understood by those skilled in the art. The material that forms each of the pair of security vehicle body connectors 130' is also preferably flexible so that when exposed to various amounts of strain, each of the pair of security vehicle connectors 130' will not fail. Each of the pair of security vehicle connectors 130' preferably includes a "U" shape, wherein each of the upper ends of the "U" are connected to the pair of security vehicle bodies, as illustrated in FIG. 1. More specifically, one end of each of the "U" shaped security vehicle connectors 130' is preferably connected to a front of one of the security vehicle bodies 38', 39' and the other end of each of the "U" shaped security vehicle connecters 130' is preferably connected to a rear of the other one of the security

vehicle bodies so that the front of one of the security vehicle bodies 38', 39' is collapsibly connected to the rear 43 of the other one of the security vehicle bodies 38', 39', as illustrated in FIGS. 20-21.

Each of the pair of security vehicle bodies 38', 39' preferably includes a pair of security vehicle connector receivers 132' connected to one of the sidewalls. Each of the pair of security vehicle connector receivers 132' are rotatably connected to the sidewall of each of the pair of security vehicle bodies 38', 39' so that the security vehicle 40' is positioned in the extended position when each of the security vehicle connector receivers 132' are positioned in a first predetermined position R_1, as illustrated in FIG. 20, and the security vehicle 40' is positioned in the collapsed position E_2 when the security vehicle connector receivers 132' are positioned in a second predetermined position R_2, as illustrated in FIG. 2. For example, as illustrated in FIG. 20, the security vehicle connector receiver 132' is positioned vertically adjacent portions of the sidewalls of each of the pair of security vehicle bodies 38', 39' when positioned in the first predetermined position R_1. Similarly, as illustrated in FIG. 21, the security vehicle connector receiver 132' is positioned horizontally adjacent portions of the sidewalls of each of the pair of security vehicle bodies 38', 39' when positioned in the second predetermined position R_2.

As perhaps best illustrated in FIG. 20, each of the security vehicle connector receivers 132' are preferably positioned to connect to a security vehicle connector extension 134' positioned to extend from either the front or the rear of each of the pair of security vehicle bodies 42', 43'. The front or the rear of each of the pair of security vehicle bodies 38', 39' can be determined by the path of travel of the security vehicle

40'. Therefore, each of the security vehicle connector extensions 134' are positioned along the front or rear of each of the pair of security vehicle bodies 42', 43' so that the security vehicle bodies 38', 39' can be connected to one another by the pair of security vehicle connectors 130'.

Each of the security vehicle connector extensions 134' preferably include a plurality of openings 136'. Similarly, each of the security vehicle connector receivers 132' also include a plurality of openings 130' that serially align with the plurality of openings 130' on each of the security vehicle connector extensions 134'. Each of the security vehicle connector receivers 132' are preferably connected to each of the security vehicle connector extensions 134'. A connecting member, such as a nut and bolt combination for example, can advantageously be used to connect each of the security vehicle connector receivers 132' to each of the security vehicle connector extensions 134'. Although a bolt and nut combination is described above, any other type of connector can be used to connect each of the security vehicle connector receivers 132' to each of the security vehicle connector extensions 134' that has high strength properties and is capable of allowing free rotational movement of the security vehicle connector receiver 132 when connected to the security vehicle connector extension 134' so that the security vehicle 40' can be readily positioned between the extended position E_1 and the collapsed position E_2.

Each of the security vehicle connector receivers 132' can advantageously be locked into position by placing another connecting member into another of the plurality of openings 136' that are serially aligned with each of the plurality of openings 136' in each of the security vehicle connector extensions 134'. For example,

if it is desired to position the security vehicle 40' in the extended position E_1, the security vehicle connector receivers 132' can be locked in a position corresponding to the security vehicle 40' being positioned in the extended position E_1. Similarly, if it is desired to position the security vehicle 40' in the collapsed position E_2, the security vehicle connector receivers 132' can be locked in a position corresponding to the security vehicle 40' being positioned in the collapsed position E_2.

The controller connected to the security vehicle the security vehicle 40' to receive the control signal emitted from the control signal emitter is preferably adapted to emit a control signal to position the security vehicle 40' between the extended and the retracted positions E_1, E_2. More particularly, the security vehicle 40' is preferably positioned between the extended and the retracted positions E_1, E_2 responsive to the remote controller that receives a control signal from the remote controller, as best illustrated in FIG. 2. This advantageously allows the security device to be positioned between the extended and the retracted positions E_1, E_2 remotely. For example, the security device can be positioned to move through an aisle of a commercial airplane in the extended position E_1, as illustrated in FIG. 1. When the security vehicle encounters a narrow space that must be accessed, e.g., the row between the passenger seats as best illustrated in FIG. 1, the operator can use the remote controller to position the security vehicle in the collapsed position E_2 so that the security vehicle 40' can be readily positioned to access narrow areas. The security vehicle 40' is preferably responsive to the encoded control signal received from the remote controller, as best illustrated in FIG. 2. For example, and as previously noted, the control signal receiver positioned on portions

of the security vehicle, can advantageously be provided by a controller positioned to receive the control signal from the remote controller.

Each of the pair of security vehicle bodies 38', 39' illustrated in FIGS. 20-22 can advantageously have various vertical heights. It is preferable, however, that each of the pair of security vehicle bodies 38', 39' height is less than about twelve inches, and more preferably between the range of about four to seven inches. As illustrated in FIGS. 20-22, the pair of security vehicle body connectors 130' can increase the total height of the security vehicle 40'. When the security vehicle 40' is positioned in the extended position E_1, as best illustrated in FIG. 20, the total height of the security vehicle is preferably between the range of seven to thirty inches. When the security vehicle 40' is positioned in the collapsed position E_2, as illustrated in FIG. 21, the height can increase to about forty inches. The security vehicle 40' can advantageously have a width of between about ten to twenty-four inches, but preferably about seventeen inches. A width of seventeen inches in the extended position E_1, is preferable because this is approximately the width of a conventional aisle in an commercial airplane when the security vehicle 40' is positioned in the collapsed position E_2, the width can advantageously be decreased to about four inches. This width is advantageous because the security vehicle 40' can then be readily positioned between rows of seats on a commercial aircraft. A security vehicle 40' having a vertical height between about four to seven inches is advantageous because it can readily be positioned to extend beneath cars and within tight spaces encountered on a commercial airplane, for example.

The drive assemblies of the security vehicle 40'

illustrated in FIGS. 20-22 are preferably connected to each one of the pair of security vehicle bodies 38', 39'. Each of the drive assemblies are preferably also connected to the pair of security vehicle connectors 130' so as to drive the omni-directional wheels 90 and to raise and lower the pair of security vehicle connectors 130' responsive to a control signal received from the remote controller. The drive assemblies preferably drive the pair of security vehicle connectors 130' so that the security vehicle 40' can be positioned between the extended position E_1 and the collapsed position E_2. Each of the drive assemblies are preferably positioned within a respective one of the security vehicle bodies 38', 39' and, more particularly, within the cavity of each of the security vehicle bodies 38', 39'. More particularly, the drive assemblies are positioned to extend between the interior periphery portions of the first and second sides of each of the respective security vehicle bodies 38', 39'.

The present invention further advantageously includes a method of maneuvering a security vehicle 40' having a base with a longitudinal axis, a low clearance, and at least one security device connected thereto. The method preferably includes moving the security vehicle 40' in a first predetermined direction so that the longitudinal axis of the security vehicle 40' is substantially parallel to the path of travel of the security vehicle 40'. The method can also advantageously include moving the security vehicle 40' in a second predetermined direction so that the longitudinal axis of the security vehicle 40' is substantially perpendicular to the path of travel of the security vehicle 40'. The method can further advantageously include moving the security vehicle 40' in a third predetermined direction so that the longitudinal axis of the security vehicle 40' is substantially transverse to the path of travel of the

security vehicle 40'.

The method of maneuvering the security vehicle 40' can still further advantageously include maneuvering the security vehicle 40' in a predetermined area having a clearance of less than about twelve inches and retracting a security device cover to thereby provide access to the security device connected to the security vehicle 40'. The method can also advantageously include extending a security device to a position away from the security vehicle 40' and retracting the security device to a position close to the security vehicle 40'. The method can further advantageously include retracting the security device cover to thereby cover the security device connected to the security vehicle 40'. The method preferably includes collapsing the security vehicle 40' to thereby provide a narrow security vehicle having a short width that can readily access areas.

The present invention also advantageously includes a method of conducting surveillance with a security vehicle 40 having a base with a longitudinal axis, a lateral axis, at least one security device connected thereto, and a predetermined effective range. The method includes moving the security vehicle 40 in a first predetermined direction so that the longitudinal axis is substantially parallel with a path of travel of the security vehicle 40 and the lateral axis is substantially perpendicular with the path of travel of the security vehicle 40. The method also includes extending the at least one security device from the security vehicle 40 to thereby expand the predetermined effective range of the security vehicle 40. The method further advantageously includes moving the security vehicle 40 in a second predetermined direction so that the longitudinal axis is substantially perpendicular to the path of travel of the security vehicle 40 and the lateral axis is substantially parallel to the path of travel of the security vehicle

40.

The method of conducting surveillance also preferably includes moving the security vehicle 40 in a third predetermined direction so that the longitudinal axis and the lateral axis are both substantially transverse the path of travel of the security vehicle 40 and retracting the at least one security device to the security vehicle 40.

The present invention also advantageously includes a method of forming an omni-directional wheel 90 for providing multi-directional movement. The method of forming the omni-directional wheel 90 can advantageously include integrally forming a wheel hub having a plurality of pairs of wheel member mounting arms 107 extending outwardly therefrom, forming a plurality of recesses in outer periphery portions of the wheel hub, and connecting a plurality of wheel members 110 between each of the plurality of pairs of wheel member mounting arms 107, and operating each of the plurality of wheel members 110 independently of another one of the plurality of wheel members 110 and independently of the wheel hub.

The method can further advantageously include extending a wheel member mounting rod through each of the plurality of wheel members 110 and connecting each of the plurality of wheel members 110 between one of the plurality of pairs of wheel member mounting arms 107 and inserting wheel member securing members through the wheel member mounting arms 107 into the wheel member connecting rod to thereby secure the wheel member 110 between one of the plurality of pairs of wheel member mounting arms 107.

The present invention also preferably includes a method of maneuvering a security vehicle having a base with a longitudinal axis and a lateral axis. The method preferably includes moving the security vehicle in a first predetermined direction through an area having a clearance of less than twelve inches so that the

longitudinal axis is substantially parallel with a path of travel of the security vehicle, and collapsing the security vehicle while moving in the first predetermined direction and moving the collapsed security vehicle through an area having a width of less than twelve inches. The method also preferably includes moving the collapsed security vehicle in a second predetermined direction so that the longitudinal axis is substantially perpendicular to the path of travel of the security vehicle. The method further preferably includes moving the collapsed security vehicle in a third predetermined direction so that the longitudinal axis is substantially transverse to the path of travel of the security vehicle. The method still further preferably includes extending the security vehicle to increase the width and decrease the height of the security vehicle while moving in the first, second, or third predetermined directions and moving the extended security vehicle in the second predetermined direction so that the longitudinal axis is perpendicular to the path of travel of the security vehicle. The method further preferably includes moving the extended security vehicle in the third predetermined direction so that the longitudinal axis is transverse to the path of travel of the security vehicle.

In the drawings and specification, there have been disclosed a typical preferred embodiment of the invention, and although specific terms are employed, the terms are used in a descriptive sense only and not for purposes of limitation. The invention has been described in considerable detail with specific reference to these illustrated embodiments. It will be apparent, however, that various modifications and changes can be made within the spirit and scope of the invention as described in the foregoing specification and as defined in the appended claims.